

**Gravina Access Project**  
***Consequences of Various Channel Closures to Large Shipping***  
***Technical Memorandum***



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## Introduction

The Alaska Department of Transportation and Public Facilities (DOT&PF) is investigating ways to improve access between Ketchikan on Revillagigedo Island and Gravina Island as part of the Gravina Access Project. Summarized here are the preliminary findings of the consequences of the following potential channel closures to large vessels calling at Ketchikan: closure of East Channel and, alternatively, closure of the north branch of Tongass Narrows in the vicinity of Charcoal Point. These closures result from the alternatives DOT&PF is considering for improved access.

An earlier report for this project (Ref. 1) briefly considered the consequence of blockages to Tongass Narrows. That report also assessed the increase in running distance (19.4 n.m.) that would result from blocking both East Channel and West Channel. This present study does not consider the effects of blocking both East Channel and West Channel.

“Approach Channels – A Guide for Design” (Ref. 2) provided the principles used in estimating the area required for navigation. As in Ref. 1, the *Carnival Conquest* class of cruise ship is here used as the design ship. The channel width, bend width and radius, and the berthing and swinging area required were calculated and then superposed to proper scale on a chart of Ketchikan harbor (Ref. 3). The consequences were then assessed.

## Navigational Area Estimates

The large cruise ships that have operated in Southeast Alaska during the 1999 season are shown in Table 3 of Ref. 1. They range in length from 596 feet overall to 915 feet overall. In addition, Table 4 of Ref. 1 shows recent deliveries and ships on order among Alaska cruise operators. The overall lengths are in the range of 781 feet to 1,021 feet. The concept design guidelines in Ref. 2 give the navigational area requirements for the “design ship” – the *Carnival Conquest* class of cruise ship. The principal dimensions of this vessel are given in Table 1.

**Table 1**  
**Principal Dimensions of *Carnival Conquest* Class**  
**Cruise Ship (Design Ship Class)**

Vessel	<i>Carnival Conquest, Glory, or Victory</i>
Length	894.0 feet
Beam	141.7 feet
Draft	27.2 feet
Speed	7.0 knots

Note: A speed of 7 knots is used, because speed in Tongass Narrows is restricted by federal regulation (33 CFR §162.240) to 7 knots between Idaho Rock and Charcoal Point.

Typically, modern cruise ships are fitted with twin propellers and twin rudders, though some older cruise ships in Alaska service have single-screw/single-rudder or twin-screw/single-rudder. In addition, many recent and planned future cruise ships are being built with bow thrusters and either high-performance rudders or azipods that enhance their maneuverability. The navigational area guidelines in Ref. 2 are based on the operation of single-screw/single-rudder ships. There are no navigational area data available for the modern cruise ships showing the advantages of twin screw/twin rudder vessels with bow thrusters. The navigational area estimates obtained from Ref. 2 are expected to apply to the lowest-common-denominator cruise ships navigating unaided by tugs and without executing special maneuvers, like tight turns or crabbing which necessitate a reduction in speed and the differential operation of their propellers/rudders and/or bow/stern thrusters.

#### Swinging Area

Section 5.3.6.5 of Ref. 2 gives guidelines on berthing and swinging areas required. If it involves swinging the ship through 180 degrees, as would be the case if East Channel were blocked to large vessels, then the swinging area is sized as a circle having a diameter approximately two times the length of the ship. For our design ship, the swinging area diameter is 1,788 feet. This is shown as a red circle in Figure 1.

#### Channel Width

Preliminary guidelines regarding channel width requirements are available in Tables 21 and 22 of Ref. 1.

#### Turning Radius

If the ship is to navigate normally, then a turning radius of four times the length is recommended for 20-degree rudder in water deeper than 1.5 times the draft (see Fig. 5.8 of Ref. 2). If the design ship is 894 feet (*Carnival Conquest*), this corresponds to a minimum turning radius of 3,576 feet, provided the water depth is at least 40 feet. Larger rudder angles will enable the ship to turn tighter. However, it is inadvisable to have bends that require larger rudder angles since that would give insufficient “reserve” rudder angle to counter wind, wave or current, and would therefore compromise safety.

The width of swept track is maximum in deep water and is then about 1.8 times the beam for a 20-degree rudder angle. For the design ship this width is 255 feet. The width of the navigable channel in the bend should be no less than that of the straight channel. Guidelines regarding channel width requirements are available in Tables 21 and 22 of Ref. 1.

The 20-degree rudder turns are shown as red arcs on a chart of Ketchikan harbor in Fig. 1.

### **Closure of East Channel – Assessment of Consequences**

This section considers the consequences of closing East Channel to large shipping at a location south of the Ketchikan cruise ship docks.

1. The 20-degree rudder turn plotted in Fig. 1 for vessels proceeding to or from the south of the Ketchikan cruise ship docks via the West Channel (red dashed arc) is practically infeasible due to insufficient water depth over Pennock Reef. The alternative is to proceed to the north of Pennock Reef and, after slowing down, to make the necessary turn either with tug assistance or with differential operation of the propellers and/or bow/stern thrusters (green line). Large cruise ships normally avoid this by taking the East Channel instead of the West Channel. In this connection it is noted that the Coast Pilot (Ref. 4) indicates that large ships from the south frequently take the West Channel and navigate around Pennock Reef so as to make a port landing at the Ketchikan cruise ship docks. This is contradictory to the information that has been obtained from the pilots and shipping agents, including Ref. 5. We have therefore concluded that the Coast Pilot information appears outdated and does not reflect current practice applicable to the large cruise ships calling at Ketchikan today. For these ships, the route via the West Channel and around Pennock Reef is not normal. Besides being a difficult maneuvering exercise, the additional maneuvering required will add time to the operations and may also require assist tugs where such assistance is currently not required. The difficulty is heightened for the case of southbound cruise ships docked *port side to* at the pier. These ships must make a 180-degree turn to starboard followed by another 180-degree turn to port in order to get to the head of West Channel and line up with the channel orientation.
2. The wind vectors in the West Channel are expected to be less “confused” than they are in the general area of the cruise ship anchorage where deflection off Deer Mount and other ridges make the winds more troublesome. It is in the area where the winds are troublesome that cruise ships using the West Channel need to accomplish some complex maneuvering turns. The judgment of one cruise shipmaster is that large cruise ships should only attempt the passage of West Channel under wind conditions less than Beaufort Force 4 (11-16 knots). However, one local marine pilot did not share this degree of concern.<sup>1</sup>

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<sup>1</sup> It must be observed that shipmasters and marine pilots share responsibility in pilotage waters. Accordingly both the master and the pilot must agree on the advisability of a proposed maneuver.

3. The cruise ship anchorage and the cruise ship tender traffic areas are shown in Fig. 1 (blue circle and blue lines). At present, only cruise ships to or from the north of the cruise ship docks pass through the anchorage. If the East Channel were to be closed, the vessels proceeding to the south of the Ketchikan cruise ship docks will also need to pass through the anchorage en route to West Channel. This will increase traffic through the cruise ship anchorage.
4. If the East Channel were to be closed, vessels leaving the cruise ship docks will need to swing through 180 degrees either with tug assistance or by operating their bow/stern thrusters. The area required for berthing and swinging is indicated in Fig. 1 (red circle). Some interference to cruise ship tender traffic may be expected.
5. Clearing the wreck marked by the red buoy WR6 and providing a minimum water depth of 6 fathoms in this area will open up additional maneuvering room for marine traffic. However, this is not going to make the West Channel route feasible for large cruise ships since the difficulties mentioned in Item 1 will still remain.

The maneuver around Pennock Reef, the passage of West Channel, and the increased traffic through the anchorage and across tender traffic lanes, all have adverse safety implications.

The operational alternative would be for cruise ship traffic to arrive and depart only through the north branch of Tongass Narrows. As noted in Ref. 1, this would result in an increase of approximately 19.4 n.m. in the running distances for cruise ships calling at Ketchikan (roughly equivalent to an additional one hour running time<sup>2</sup>). This would alleviate the risk associated with maneuvering around Pennock Reef and that associated with the passage of West Channel, but all other impacts (including the adverse safety impacts of increased traffic through the anchorage and across tender traffic lanes) would remain.

### **Closure of Tongass Narrows Near Charcoal Point – Assessment of Consequences**

This section considers the consequences of closing Tongass Narrows at any location north of the Ketchikan cruise ship docks but presumably in the vicinity of Charcoal Point.

Two different traffic patterns must be considered if Tongass Narrows is closed to large shipping north of the cruise ship docks:

- Ships arrive in Ketchikan via either East Channel or West Channel, and depart via the opposite channel.

<sup>2</sup> The sailing distance in speed restricted waters (7 knot maximum per 33 CFR § 162.240 (b)) is approximately 0.31 n.m. greater to the north of the Ketchikan cruise ship pier than to the south. Taking that difference into account the additional running time is approximately one hour for a cruise ship with 20-knot service speed and approximately 1 hour 20 minutes for a cruise ship with 15-knot service speed.

- Large ships enter and depart Ketchikan via East Channel.

As noted in the earlier report (Ref. 1), regardless of which of the two traffic patterns is adopted, closing Tongass Narrows to large ships in the vicinity of Charcoal Point will add approximately 30.5 n.m. running distance for ships calling at the Ketchikan cruise ship docks.

#### Large Shipping Uses both East and West Channels

The consequences of large shipping using both East and West Channels (arriving via one channel and departing via the opposite channel) would be almost identical to closing East Channel (considered above) except that it would not be necessary for vessels calling at the Ketchikan cruise ship dock to execute an  $\sim 180^\circ$  turn upon departure as is necessary if East Channel is blocked (as considered above).

1. The 20-degree rudder turn plotted in Fig. 1 for vessels proceeding to or from the south of the Ketchikan cruise ship docks via the West Channel (red dashed arc) is practically infeasible due to insufficient water depth over Pennock Reef. The alternative is to proceed to the north of Pennock Reef and, after slowing down, to make the necessary turn either with tug assistance or with differential operation of the propellers and/or bow/stern thrusters (green line). Besides being a difficult maneuvering exercise, this maneuver will add time to the operations and may also require assist tugs where such assistance is currently not required. Large cruise ships currently avoid this turn around Pennock Reef. In this connection it is noted that the Coast Pilot (Ref. 4) indicates that large ships from the south frequently take the West Channel and navigate around Pennock Reef so as to make a port landing at the Ketchikan cruise ship docks. This is contradictory to the information that has been obtained from the pilots and shipping agents, including Ref. 5. We have therefore concluded that the Coast Pilot information appears outdated and does not reflect current practice applicable to the large cruise ships calling at Ketchikan today. For these ships, the route via the West Channel and around Pennock Reef is not normal.
2. The cruise ship anchorage and the cruise ship tender traffic area are shown in Fig. 1 (blue circle and blue lines). At present, only cruise ships to or from the north of the cruise ship docks pass through the anchorage. If Tongass Narrows were closed to large ships in the vicinity of Charcoal Point and ships arrived via either East or West Channel and departed via the opposite channel, then the traffic volume through the anchorage would be similar to the present circumstances but the maneuver executed in the anchorage, including the possibility of tug assistance, would be more extreme.
3. Clearing the wreck marked by the red buoy WR6 and providing a minimum water depth of 6 fathoms in this area will open up additional maneuvering room for marine traffic. However, this is not going to make the West Channel route feasible for large cruise ships since the difficulties mentioned in Item 1 will still remain.

4. Given the additional time necessary to perform the turn around Pennock Reef and the approximately 30.5 n.m. additional running distance resulting from closure of Tongass Narrows to the north, the time penalty for cruise ships calling at Ketchikan will be on the order of 2 to 2.5 hours.

#### Large Shipping Arrives and Departs Via East Channel Only

The consequences of large shipping both arriving and departing via East Channel is to eliminate the turn around Pennock Reef and through the cruise ship anchorage in exchange for the necessity of executing an  $\sim 180^\circ$  turn, either on arrival or upon departure, in the berthing and swinging area off the Ketchikan cruise ship dock.

1. If all large ship arrivals and departures made use of East Channel it would be necessary for each ship to execute an approximately  $180^\circ$  turn, either on arrival or upon departure, in the berthing and swinging area off the Ketchikan cruise ship dock. The wind in the general area of this turning and swinging area is reported to be very unsteady due to deflections off Deer Mount and other adjacent ridges. While modern cruise ships outfitted with bow thrusters and azipods should have relatively little difficulty making this  $\sim 180^\circ$  turn, older cruise ships lacking modern maneuvering features such as bow thrusters, azipods or high-performance rudders, may find it necessary to obtain assistance from harbor tugs where such assistance is currently not required. Additional time would be required to execute this  $\sim 180^\circ$  turn.
2. The cruise ship tender traffic area is shown in Fig. 1 (blue lines). Ships arriving and departing via East Channel would have to execute  $\sim 180^\circ$  turn, possibly with tug assistance, in the area that includes the cruise ship tender traffic from anchored cruise ships.
3. Clearing the wreck marked by the red buoy WR6 would do little to improve cruise ship maneuvering if both arrivals and departures were via East Channel.
4. Given the additional time necessary to perform the  $\sim 180^\circ$  turn and the approximately 30.5 n.m. additional running distance resulting from closure of Tongass Narrows to the north, the time penalty for cruise ships calling at Ketchikan will be on the order of 2 to 2.5 hours.

#### **Conclusions**

Either closing East Channel to large cruise ships or closing Tongass Narrows in the vicinity of Charcoal Point would result in the necessity of cruise ships routinely accomplishing difficult maneuvers, either consisting of turns around Pennock Reef and transiting West Channel and/or an  $\sim 180^\circ$  turn in the berthing and swinging area. Some ships lacking modern maneuvering features such as bow thrusters, azipods or

high-performance rudders may find it necessary to engage harbor assist tugs where such assistance is currently not required<sup>3</sup>.

Closure of East Channel or closure of Tongass Narrows in the vicinity of Charcoal Point with large ships making use of both East and West Channels, would result in increased traffic through anchorage and across tender traffic from anchored cruise ships.

Any of the potential closures would result in increased running distances and corresponding travel time for cruise ships calling at Ketchikan.

Any of the potential channel closures to large ships could have adverse impacts to operations of these vessels as a result of i) increases in maneuvering time, ii) increases in sailing distances (i.e., for ships unwilling to use West Channel), iii) increases in direct expenses associated with requirements for more assist tug services, and iv) decreases in safety due to the need for more complex maneuvers in congested areas. These factors would likely result in increased costs of operations for large vessels calling at Ketchikan.

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<sup>3</sup> The majority of large cruise ships operating seasonally in Alaska have bow thrusters, while perhaps 20% have high-performance rudders and currently no cruise ships fitted with Azipods operate in Alaska (though three ships with Azipods are anticipated in the 2001 cruising season). It is anticipated that, over a long time frame (perhaps twenty to thirty years) an ever-increasing number of large cruise ships will be fitted with Azipods or high-performance rudder systems. One Ketchikan marine pilot has observed that even ships with modern maneuvering features may require additional tug assistance to perform these maneuvers under adverse environmental conditions. This same pilot went on to state that, regardless of features, some cruise companies might require tugs as a matter of general policy.



## References

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